MARSHALL PROCEDURAL REQUIREMENTS

DA01

FLIGHT SYSTEMS DESIGN/DEVELOPMENT CONTROL

DOCUMENT HISTORY LOG

Status (Baseline/ Revision/ Canceled)	Document Revision	Effective Date	Description
Baseline		5/14/99	Document converted from MSFC-P04.1 to a Directive. Previous history retained in system as part of canceled or superseded ISO Document files.
Revision	A	8/20/99	Revision to incorporate the new MSFC ISO scope. Revised the types of reviews to be consistent with current industry practices.
Revision	B	12/6/99	Clarify scope to be limited to design of flight systems. Revise Para. 3.1.2 to delete text on Project Plan content (see MPG 7120.1). Revise Fig. 1 to delete R&T activities. Delete extraneous definitions. Added callout for MWI 8050.1.
Revision	C	4/24/01	Update to ISO9001:2000; clarify project roles/responsibilities; and tailor definitions to be consistent with document scope.
Revision	D	2/28/03	Update of Verification and Validation definitions and usage for consistency with Agency definitions. Corrected reference from MSFC-STD-555 to MPG 8040.1. Corrected Master List URL. Corrected reference from MSFC-HDBK-1912 to MSFC-HDBK-3173. Minor text changes for requested clarifications.
Revision	E	5/15/03	Updated paragraphs 3.4.2, 3.5.3 to add text for compliance with AS9100, Rev. A. Corrected paragraph numbers in Fig.1. Added reference to MWI 8060.3
Revision	F	9/26/2004	Updated mandatory requirements to "shall" to clarify requirements per HQ Rules Action. Updated para. 3.9 to update applicable CM documentation. Changed document type from MPG to MPR. Added definitions for "formulation" and "flight system" and added references for others. Added requirement for traceability. Clarified responsibilities in several paragraphs. Added reference to MSFC-HDBK-3173 for design reviews.

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PREFACE

P.1 PURPOSE

The purpose of this procedure is to define the methods and responsibilities for design/development control of flight systems at Marshall Space Flight Center (MSFC). Implementation of this procedure shall satisfy the requirements of the "Marshall Management Manual" (MMM), MPD 1280.1.

P.2 APPLICABILITY

This procedure shall be applied to flight hardware, software, and associated ground support equipment design activities performed at or under the direction of MSFC. (Reference MPR 8823.1 for Facilities Design Control and MPR 8060.2 for Non-Flight and Non-Facility Design and Development.)

P.3 AUTHORITY

MPD 1280.1, "Marshall Management Manual"

P.4 APPLICABLE DOCUMENTS

a. MPD 1280.1, "Marshall Management Manual"

b. MPR 8040.1, "Configuration Management, MSFC Programs/Projects"

c. MPR 1280.2, "Process Control"

d. MPR 8730.1, "Inspection and Testing"

e. MWI 8050.1, "Verification and Validation of Hardware, Software, and Ground Support Equipment for MSFC Projects"

f. NPR 7120.5, "NASA Program and Project Management Processes and Requirements"

g. MPR 8060.3, "Requirements and Design Reviews, MSFC Programs/Projects"

h. NPR 1441.1, "NASA Records Retentions Schedules" (NRRS)

i. MSFC-STD-3394, "Standard for Contractor Configuration Management Requirements, MSFC Programs/Projects"

P.5 REFERENCES

a. MSFC-HDBK-3173, "Project Management and Systems Engineering Handbook"

b. MPR 8823.1, "Design Control of Facilities"

c. MPR 8060.2, "Non-Flight and Non-Facility Design and Development"

d. MSFC-STD-555, MSFC Engineering Documentation Standard

P.6 CANCELLATION

MPG 8060.1E dated May 15, 2003

Original signed by
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DOCUMENT CONTENT

1. ACRONYMS AND DEFINITIONS

1.1 <u>CCBD</u>. Configuration Control Board Directive. (See MPR 8040.1)

1.2 <u>Design/Development Output</u>. Result of the design/development process (e.g., drawings, sketches, models, prototype/first article and computer code). Design/development output also includes necessary supporting documentation (e.g., operating instructions, analyses, ICDs, technical plans, etc.).

1.3 <u>Design/Development Process</u>. An organized effort by technically trained personnel to create a design/development output that will produce a defined result within a specified budget to a predetermined schedule.

1.4 <u>DRL</u>. Documentation Release List. (See MSFC-STD-555)

1.5 <u>ECR</u>. Engineering Change Request. (See MPR 8040.1)

1.6 <u>EO</u>. Engineering Order. (See MSFC-STD-555)

1.7 <u>EPL</u>. Engineering Parts List. (See MSFC-STD-555)

1.8 <u>FEO</u>. Floor Engineering Order. (See MSFC-STD-555)

1.9 <u>FEPL</u>. Floor Engineering Parts List. (See MSFC-STD-555)

1.10 <u>First Article</u>. The first item produced judged to meet the customer requirements; this could be the first unit built, the structural qualification unit, proto-flight unit, etc.

1.11 <u>Flight System</u>. Any hardware or software that is intended to fly in, or is part of, the Space Transportation System (STS) or some other flight system. Hardware and software intended to fly on a balloon flight, sounding rocket, or aircraft flight are excluded from this definition.

1.12 <u>Formulation</u>. The PAPAC (Provide Aerospace Products and Capabilities) subprocess used to define the program/project concept and plan to meet the customer requirements.

1.13 <u>Key Characteristics</u>. The features of a material, process, or part whose variation has a significant influence on product fit, performance, service life, or manufacturability.

1.14 <u>LSE</u>. Lead System Engineer (See para. 2.2)

1.13 <u>LSSE</u>. Lead Subsystem Engineer (See para. 2.3)

1.14 <u>Product</u>. The deliverable(s) provided to the customer in response to their stated requirements.

1.15 <u>Record</u>. A document maintained to demonstrate both MSFC conformance to specified requirements and the effective operation of the MSFC system.

1.16 <u>Validation</u>. Proof, by examination of objective evidence, that the product accomplishes the intended purpose. Validation is performed to ensure that the product is ready for a particular use, function, or mission and may be determined by test, analysis, demonstration, or a combination of these.

1.17 <u>Verification</u>.   Proof, by examination of objective evidence, that the product complies with specifications. Verification is performed to ensure the product complies with requirements and may be determined by test, analysis, demonstration, inspection, or a combination of these.

2. RESPONSIBILITIES

2.1 <u>Project Manager</u> shall be responsible for the planning, definition, and timely accomplishment of the project. The Project Manager shall ensure adequacy of inputs/outputs, cognizance of affected parties, proper identification and retention of records, and ensure that the product meets the requirements.

2.2 <u>Lead System Engineer (LSE)</u> shall be responsible for ensuring the adequacy of inputs/outputs, technical functions as required, and supports the project manager in determining the product meets the requirements. Note: For small or less complex tasks or activities, the project manager and LSE may be the same person.

2.3 <u>Lead Subsystem Engineers (LSSE)</u> shall be responsible for technical performance of their assigned subsystems/elements and for accomplishing and documenting the design. Generally, there will be multiple LSSE's on a project team.

3. PROCEDURE

The following procedures are examples of the general flow, with associated steps, in the design process for flight hardware, software, and associated ground support equipment, but do not always reflect the iterative nature of the actual process. The procedures describe activities associated with different parts of the design process. The general design process flow for a complex project is shown in Section 5. The inclusion of all the activities, combining activities, or adding activities, is dependent upon the complexity and scope of the individual project and the customer requirements. The project manager and LSE may utilize concurrent engineering and product development teams to accomplish the design process.

Changes to the project schedule, design requirements, available resources, interim test results, failure investigations, or other unpredictable constraints may require parallel activities and/or repetition of design activities as determined by the project manager and lead systems engineer. Projects that have a limited scope, low complexity and low risk, or are repetitive, can follow a greatly simplified process. For example, if the process is to test a customer-supplied propulsion system and provide a data report, and little or no design is involved, verification/ validation would be limited to "ready-to-test." However, process control to ensure that the design output and product meet the specified requirements shall be maintained.

Actionee		Action

Project Manager shall	3.1	Design and Development Planning

Determine the design process required for an individual project, based on the technical requirements of the project and the customer needs. During the formulation phase, in concert with the project team and the customer, define the design process, utilizing MSFC-HDBK-3173 as a guideline, in a project plan (see NPR 7120.5 for a project plan template).

Depending on the complexity of the project, the project plan may require more detailed plan(s) for design and development. Such plan(s) shall define each design and development activity, the individual or organization responsible for its implementation, facilities, or test equipment needed, and the attendant schedule. Each activity shall be assigned to qualified personnel with adequate resources. The plan shall be reviewed regularly and updated, as needs dictate.

Project Manager shall	3.2	Organizational and Technical Interfaces
	3.2.1	Ensure the customer is apprised of the project status.
	3.2.2	Define the technical functions among different organizations that input into the design process.
	3.2.3	Ensure that necessary design information is documented, transmitted, and reviewed on a regularly scheduled basis as defined by the project plan, and resources are coordinated within the development group.
	3.3	Design Input

Project Manager shall	3.3.1	Provide the initial project requirements to the design team by reviewing customer requirements, applicable statutory and regulatory requirements, relevant information from previous similar designs, and any other requirements deemed essential for product design and development.
LSE shall	3.3.2	Lead project team in review of project requirements, identify any problems or concerns, and ensure resolution and traceability of requirements from the customer through end item specifications. Requirement reviews shall be conducted in accordance with MPR 8060.3.
Project Manager/ LSE shall	3.3.3	Resolve any incomplete, ambiguous, or conflicting requirements with the customer and updates the contract/agreement as appropriate. Approved project requirements (e.g., system specification, system requirements document) shall become a record.
	3.4	Design Output
LSE/LSSE shall	3.4.1	Ensure the design output is documented:
	3.4.1.1	Consistent with the design input requirements utilizing MPR 8040.1 to ensure proper content.
	3.4.1.2	Ensure the design output documents are reviewed and approved prior to release, in accordance with the project configuration management plan, project plan, and design review plan.
LSE/LSSE shall	3.4.2	Ensure the design output can be assessed against the project requirements, provides appropriate information for purchasing, production, and for service provisions, contains or references acceptance criteria, specifies product characteristics essential for its safe and proper use and identifies key characteristics, when applicable, in accordance with design or contractual requirements.
Originating Organization	3.4.3	The responsible office(s) for developing design output shall maintain this documentation.
	3.5	Design Review

Project Manager

Design reviews shall ensure that the system design requirements and objectives are clearly stated and the design will meet these requirements. The presentation of the design shall allow detailed, objective evaluation of the design functionality, producibility, and the adequacy of the verification and validation.

Project Manager shall

3.5.1   Appoint the design review committee, with members from all organizations, including the customer, concerned with the design stage being reviewed. The committee may be as few as two members for very simple or standard projects.

Project Manager shall

3.5.2   Ensure that the appropriate design reviews are conducted. The design review process may include as many reviews as necessary, as defined by the project manager and described in the Project Plan. Design reviews shall be conducted in accordance with MPR 8060.3. See MSFC-HDBK-3173 for a description of candidate reviews.

Project Manager shall

3.5.3   The results (e.g., minutes, report) of a design review shall be documented and approved by the project manager. These results shall become a record and as a minimum shall include the following:

a. Project identifier and type of review

b. Scope of review

c. Review team membership

d. Findings, issues, action items, and closure plans

e. Authorization for progression to next design/development stage.

3.6   Verification

LSE/LSSE

3.6.1   Verification provides evidence that the product (including all hardware, software, and interfaces) meets the input requirements. This evidence may consist of tests, analyses, demonstrations, and inspections (as described in the project verification planning). Actionees shall ensure, per MWI

8050.1:

3.6.1.1   Ensure verifications are performed by the project team at appropriate intervals to confirm that the product meets all its specifications.

3.6.1.2   Ensure the results of each verification are documented and become a record. It shall include the following:

a. Project identifier

b. Scope of verification

c. Method of verification

d. Summary of findings, issues, and action items

e.   Closure or closure plan of findings, issues, and action items
f.   PM/LSE approval

3.6.1.3   Other documentation that describes the item verified shall be maintained by the responsible organization.

3.7   Validation

LSE/LSSE   3.7.1   Validation provides objective evidence, including resolution of all action items, issues and findings, that the product meets the input requirements for its intended use. This evidence may consist of tests, analyses, and demonstrations (as described in the validation planning) This objective evidence is obtained on the final product and is accomplished prior to customer delivery. (Note: Where intended use is defined in the design input/specifications, product validation may be included within product verification.) The actionees shall ensure, per MWI 8050.1:

3.7.1.1   Validation is conducted to confirm that the product, for example, black box, software, valve, test system, or data, meets the customer's requirements and intended purpose.

3.7.1.2   Results of a validation shall be documented and become a record. It shall include the following:

a. Project identifier

b. Scope of validation

c. Method of validation

d. Summary of findings, issues, and action items

e. Closure or closure plan for findings, issues, and action items, including any constraints

f. PM/LSE approval

3.7.1.3 Other documentation that describes the product validation shall be maintained by the responsible organization. Compliance data will be retained as described in MWI 8050.1.

Manufacturing Organization

3.8 Fabrication and Assembly

Fabrication and assembly shall be accomplished utilizing the controls of MPR 1280.2 and MPR 8730.1.

3.9 Design Changes

Design changes shall be accomplished utilizing MPR 8040.1. Records of review/approval of design changes and associated actions shall be maintained in accordance with MPR 8040.1. The project plan (see 3.1 above) shall define the configuration management requirements for the project. The project plan for contracted activities shall utilize MSFC-STD-3394 for contractor configuration management requirements. The project shall ensure customer and/or regulatory authority approval of changes when required by contract or regulatory requirement. Configuration Management Plans should be baselined as early as practical in the formulation phase and be available for design. Note: See NPR 7120.5 for guidelines on utilization of project configuration management activities.

Project Team shall

3.9.1 Identify, review, evaluate impact on constituent parts and delivered products, and document any project design changes in accordance with the project configuration management plan.

Project Manager

3.9.2 Review and approve any design changes or modifications

shall		before their implementation, per the configuration management control system defined in the project plan.
Project Manager shall	3.9.3	Ensure that the customer approves any design changes or modifications which potentially affect the customer's requirements before implementation.

4. RECORDS

Records required by this MPR are as follows:

4.1 Approved project requirements (ref: paragraph 3.3.3)

4.2 Results of design reviews (ref: paragraph 3.5.3)

4.3 Verification and validation results (ref: paragraph 3.6.1.2, 3.7.1.2)

4.4 Records of design changes/modification (ref: paragraph 3.9)

The project manager shall determine what are project-specific records, repository where stored, retention time, and media(s) utilized, consistent with NPR 1441.1. This information shall be defined in the project Data Management Plan.

5. FLOW DIAGRAM

See Figure 1.

FIGURE 1